REPORT DOCUMENTATION PAGE

Form Approved OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
February 1991

3. REPORT TYPE AND DATES COVERED
Magazine

4. TITLE AND SUBTITLE
Gateway: Volume II Number 1

5. FUNDING NUMBERS
SPO900-94-D-0001

6. AUTHOR(S)
Gary Klein
Rik Warren
Pat Nickell
Norm Phillips

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Human Systems IAC
2261 Monahan Way, Bldg. 196
WPAFB OH> 45433-7022

8. PERFORMING ORGANIZATION REPORT NUMBER
GWII1

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Technical Information Cntr.
DTIC/AI
Cameron Station
Alexandria, VA 22304-6145

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.
Free to public by contacting the Human Systems IAC.

12b. DISTRIBUTION CODE
A

13. ABSTRACT ***(Maximum 200 Words)***

This issue contains articles on the following subjects: 1.Naturalistic Decision Making; 2.The Air Foce Lessons Learned Program; 3.Modeling Human Force Response; 4.Wanted: A Scientific Basis for Human Vehicular Control; 5.CSERIAC Conference Services;

14. SUBJECT TERMS
Naturalistic Decision Making Lessons Learned Program Air Force Human Force Response Vehicles CSERIAC Services

15. NUMBER OF PAGES
12

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

VOLUME II: NUMBER 1, WINTER 1991

CSERIAC GATEWAY

PUBLISHED BY THE CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER

In this issue:

CSERIAC is a United States Department of Defense information analysis center hosted by the Harry G. Armstrong Laboratory, Wright-Patterson Air Force Base, Ohio, and operated by the University of Dayton Research Institute.

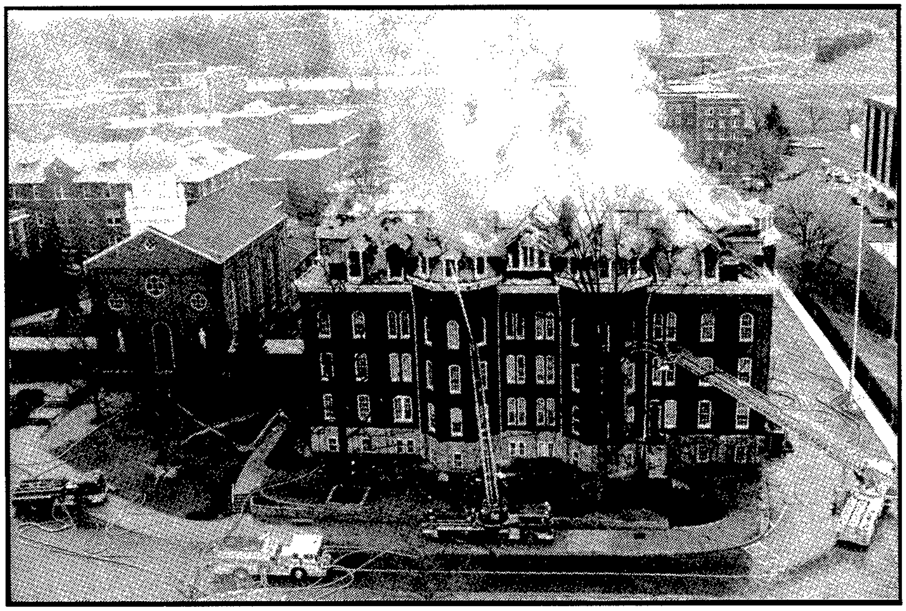


Figure 1. Four-alarm fire in St. Joseph Hall at the University of Dayton, Dayton, Ohio, on December 22, 1987. Photo by Jeff Miller

Naturalistic Decision Making

Gary Klein
David Klinger

The past five years have seen the development of a new model for understanding how people make decisions in real-world settings. Naturalistic decision making is an attempt to understand how humans actually make decisions in complex real-world settings, such as fire fighting (See Fig. 1). This work has focused on situations marked by key features as seen in Table 1. These include dynamic and continually changing conditions, real-time reactions to these changes, ill-defined tasks, time pressure, significant personal consequences for mistakes, and experienced decision makers. These task conditions exist in operational environments associated with crew systems, so it is essential to determine how people handle these conditions.

Previous models of decision making were limited in their ability to encompass these operational features. Classical approaches to decision making, such as Multi-Attribute Utility Analysis (MAUA) and Decision Analysis, prescribe analytical and systematic methods to weigh evidence and select an optimal course of action. MAUA decision makers are encouraged to generate a wide range of options, identify criteria for evaluating them, assign weights to the evaluation criteria, rate each option on each criterion, and tabulate the scores to find the best option. Decision Analysis is a technique for constructing various branches of responses and counter-responses and postulating the probability and utility of each possible future state, to calculate maximum and minimum outcomes.

On the surface these strategies may seem adequate, yet they fail to con-

Decision Making, on page 2

Table 1

FEATURES OF NATURALISTIC DECISION MAKING

❶ Ill-defined goals and ill-structured tasks ❷ Uncertainty, ambiguity, and missing data ❸ Shifting and competing goals ❹ Dynamic and continually changing conditions ❺ Action-feedback loops (real-time reactions to changed conditions) ❻ Time stress ❼ High stakes ❽ Multiple players ❾ Organizational goals and norms ❿ Experienced decision makers

Decision Making from page 1

sider some important factors inherent in real-world decisions. Classical strategies deteriorate when confronted with time pressure. They simply take too long. Under low time pressure, they still require extensive work and they lack flexibility for handling rapidly changing conditions. It is difficult to factor in ambiguity, vagueness, and inaccuracies when applying analytical methods. Another problem is that the classical methods have primarily been developed and evaluated using inexperienced subjects, typically college students.

A group of decision researchers is trying to derive models that describe how experienced decision makers actually function. Rasmussen (1985) used protocols and critical incident interviews to study nuclear power plant operators. He has a three-stage typology of skills (sensorimotor, rule-based, and knowledge-based) which highlights how differential expertise creates differences in decision strategy. Hammond, Hamm, Grassia, and Pearson (1987) studied highway engineers and found that intuitive decision strategies were more effective for tasks such as judging aesthetic qualities of a road, while analytical strategies were more valuable for tasks such as estimating amount of traffic. Pennington and Hastie (in press) studied jury deliberation as a complex decision task and found that the jurors attempted to fit all the evidence into a coherent account of the incident. Their assessment was then based on this account or story, rather than on likelihood judgments of the evidence introduced. The jurors focused on whether the prosecution's or defense's story was more coherent. The work of Noble (in press) with Naval Command-and-Control officers and Lipshitz (in press) with infantry soldiers, has generated the same conclusions—under operational conditions, decision makers rarely use analytical methods, and nonanalytical methods can be identified that are flexible, efficient, and effective.

Our work shows how people can

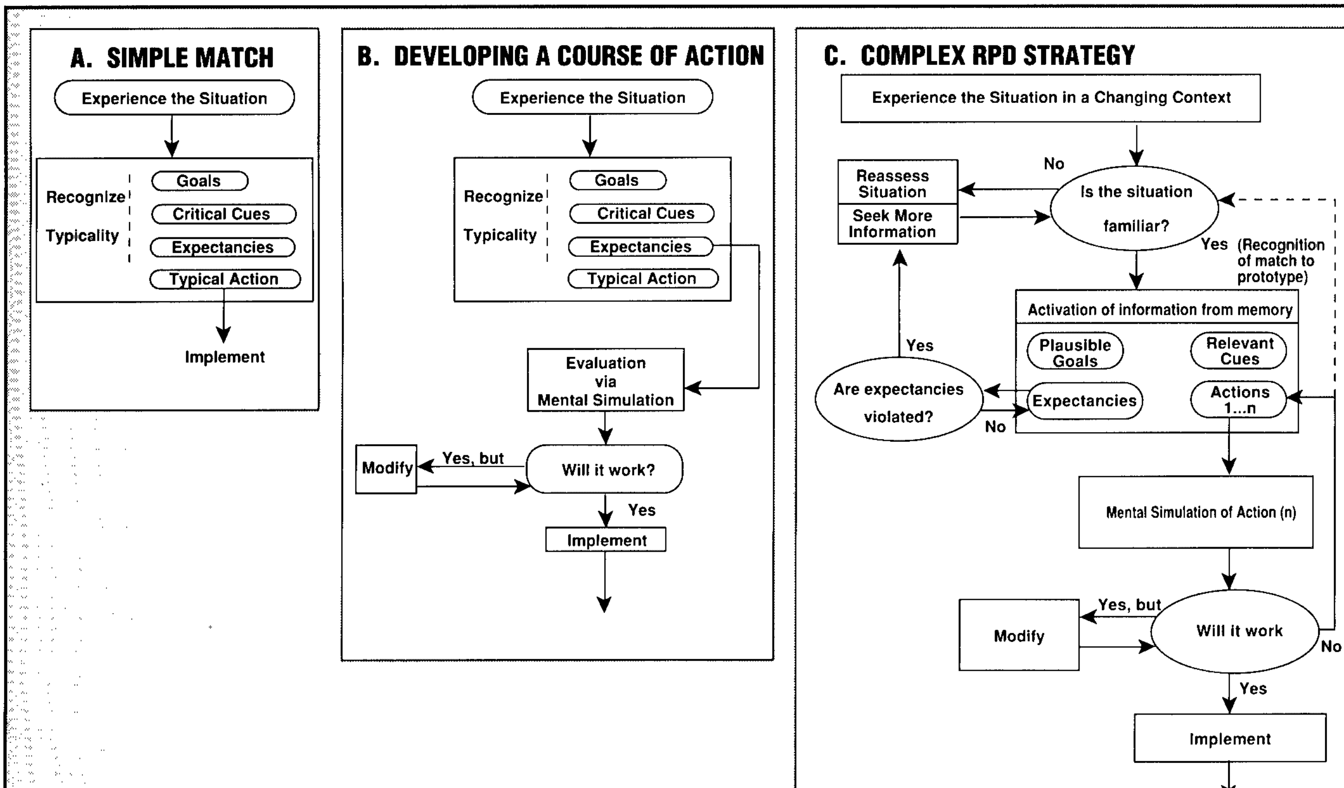


Figure 2. Recognition-Primed Decision Model

make effective decisions without performing analyses. For several years, we have studied command-and-control decision making and have generated a recognitional model of naturalistic decision making. We began by observing and obtaining protocols from urban fireground commanders (FGCs) who are in charge of allocating resources and directing personnel. We studied their decisions in handling non-routine incidents during emergency events. Some examples of these types of decisions included whether to initiate search and rescue, whether to initiate an offensive attack or concentrate on defensive precautions, and where to allocate resources.

The FGCs' accounts of their decision making did not fit into a decision-tree framework. The FGCs argued that they were not "making choices," "considering alternatives," or "assessing probabilities." They saw themselves as acting and reacting on the basis of prior experience; they were generating, monitoring, and modifying plans to meet the needs of the situations. We found no evidence for extensive option generation. Rarely were even two options concurrently evaluated. We could see no way in which the concept of optimal choice might be applied. Moreover, it appeared that a search for an optimal choice could stall them long enough to lose control of the operation altogether. The FGCs were more interested in finding an action that was "workable," "timely," and "cost effective."

Nonetheless, the FGCs were clearly encountering choice points during each incident. They were aware that alternative courses of action were possible, but insisted that they rarely deliberated about the advantages and disadvantages of the different options. Instead, the FGCs relied on their ability to recognize and appropriately classify a situation. Once they knew it was "that" type of case, they usually also knew the typical way of reacting to it. Imagery might be used to "watch" the option being implemented, to search for flaws, and to discover what might go wrong. If problems were foreseen, the option might be modified or rejected altogether and the next most typical reaction explored. This mental search continued until a workable solution was identified.

Table 2

KEY FEATURES OF RECOGNITION-PRIMED DECISION (RPD) MODEL

❶ First option is usually workable ***NOT*** random generation and selective retention ❷ Serial generation/evaluation of options ***NOT*** concurrent evaluation ❸ Satisficing ***NOT*** optimizing ❹ Evaluation through mental simulation ***NOT*** MAUA, Decision Analysis, or Bayesian statistics ❺ Focus on elaborating and improving options ***NOT*** choosing between options ❻ Focus on situation assessment ***NOT*** decision events ❼ Decision Maker primed to act ***NOT*** waiting for complete analyses

We have described these strategies as a Recognition-Primed Decision (RPD) model (Klein 1989). For this fireground task environment, a recognitional strategy appears highly efficient. The proficient FGCs we studied used their experience to generate a workable option as the first to consider. If they had tried to generate a large set of options, and then systematically evaluated these, it is likely that the fires would have gotten out of control before they could make any decisions.

Three examples of the RPD model are presented in Figure 2. The simplest case is one in which the situation is recognized and the obvious reaction is implemented. A somewhat more complex case is one in which the decision maker consciously evaluates the reaction, typically using imagery to uncover problems prior to carrying it out. In the most complex case, the evaluation reveals flaws requiring modification, or the option is judged inadequate and rejected in favor of the next most typical reaction.

The model is characterized by the following features, which are summarized in Table 2:

- Situational recognition allows the decision maker to classify the task as familiar or prototypical.
- The recognition as familiar carries with it recognition of the following types of information: plausible goals, cues to monitor, expectancies about the unfolding of the situation, and typical reactions.
- Options are generated serially, with a very typical course of action as the first one considered.
- Option evaluation is also performed serially to test the adequacy of the option, and to identify weaknesses and find ways to overcome them.
- The RPD model includes aspects of problem solving and judgment along with decision making.
- Experienced decision makers are able to respond quickly, by using experience to identify a plausible course of action as the first one considered rather than having to generate and evaluate a large set of options.
- Under time pressure, the decision maker is poised to act while evaluating a promising course of action, rather than paralyzed while waiting to complete an evaluation of different options. The focus is on acting rather than analyzing.

We do not propose the RPD model as an alternative to analytic approaches. Rather, we postulate that recognitional and analytical decision strategies occupy opposite ends of a decision continuum similar to the cognitive continuum described by Hammond et al. (1987). At one extreme are the conscious, deliberated, highly analytic strategies such as MAUA and Decision

Decision Making on page 4

Decision Making from page 3

Analysis. Slightly less analytic are non-compensatory strategies such as elimination-by-aspects. At the alternate end of the continuum are Recognition-Primed Decisions (RPD), which involve non-optimizing and non-compensatory strategies and require little conscious deliberation. RPDs are marked by an absence of comparison among options. They are induced by a starting point that involves recognitional matches that in turn evoke generation of the most likely action.

We have tested applications of the model in a variety of tasks and domains, including fireground command, battle planning, critical care nursing, corporate information management, and chess tournament play. These studies have shown good support for the validity and utility of the model presented in Figure 2 as it applies to individual decision makers. Our coding was evaluated as having 87% to 94% inter-rater reliability.

What are the implications of the naturalistic decision-making approach? A workshop in Dayton, Ohio, in Fall 1989, took stock of the current state of knowledge and explored implications and future research directions. Attending were researchers who have been active in naturalistic decision making, including 31 professionals who represented decision research being conducted by the military, NASA, private firms, and academic institutions. The domains studied spanned tactical operations, medical decision making, weather forecasting, nuclear power plant control, and executive planning, among others. This workshop was sponsored by the Army Research Institute (ARI) which began a research program in 1985 on Planning, Problem Solving, and Decision Making. The goal of this program is to make decision research more relevant to the needs of the applied community.

The Dayton workshop enabled researchers, working with different domains and paradigms, to find commonalities and to identify remaining questions. The workshop succeeded in identifying the factors of greatest interest for generalizing to operational settings. The participants documented limitations of classical decision theory, and explored opportunities for using nonanalytical models to develop better training programs and decision support systems. The participants also contributed to a book *Decision making in action: Models and methods* edited by Gary Klein, Judith Orasanu, and Roberta Calderwood (expected date of publication, 1991). It will be available through Ablex Publishing Corporation, 355 Chestnut St., Norwood, NJ, 07648.

References

Hammond, K.R., Hamm, R.M., Grassia, J., & Pearson, T. (1987). Direct comparison of the efficacy of intuitive and analytical cognition in expert judgment. *IEEE Transactions on Systems, Man, and Cybernetics, 17*(5), 753-770.

Klein, G.A. (1989). Recognition-primed decisions. In W. Rouse (Ed.), *Advances in man-machine systems research,* Greenwich, CT: JAI Press, Inc. (Vol. 5, pp. 47-92).

Klein, G.A., Orasanu, J., & Calderwood, R. (Eds.) (In press). *Decision making in action: Models and methods.* Norwood, NJ: Ablex Publishing.

Lipshitz, R. (In press). Converging themes in the study of decision making in realistic settings. In G.A. Klein, J. Orasanu, & R. Calderwood (Eds.), *Decison making in action: Models and methods.* Norwood, NJ: Ablex Publishing.

Pennington, N., & Hastie, R. (In press). A theory of explanation-based decision making. In G.A. Klein, J. Orasanu, & R. Calderwood (Eds.), *Decision making in action: Models and methods.* Norwood, NJ: Ablex Publishing.

Noble, D. (In press). A model to support development of situation assessment aids. In G.A. Klein, J. Orasanu, & R. Calderwood (Eds.), *Decision making in action: Models and methods.* Norwood, NJ: Ablex Publishing.

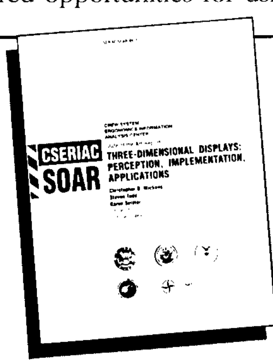
Rasmussen, J. (1985). The role of hierarchical knowledge representation n decision making and system management. *IEEE Transactions on Systems, Man, and Cybernetics, 15*(2), 234-243.

Dr. Gary Klein is the Chairman and Chief Scientist at Klein Associates, Yellow Springs, OH. David Klinger is a Research Assistant with Klein Associates.

State-of-the-Art Report

THREE-DIMENSIONAL DISPLAYS

Perception, Implementation, Applications



Christopher D. Wickens, Steven Todd, and Karen Seidler
University of Illinois

The perceptual basis of three-dimensional (3D) representation, recent advances in 3D display implementation, and current 3D design applications are examined in this authoritative review of the state of the art in 3D display technology.

The report catalogues the basic perceptual cues that can be built into a display to convey a sense of "natural" 3D viewing or depth. It describes how the various cues interact and how cues can be combined appropriately to create the strongest sense of depth.

Techniques for implementing perspective and stereoscopic displays are described in detail. The report identifies some potential costs and risks associated with 3D display technology, including the potential for perceptual ambiguity. Ways of constructing 3D displays to reduce ambiguities are suggested.

The efficacy of 3D vs. 2D representation is compared for various display contexts, and the most useful 3D applications environments are noted.

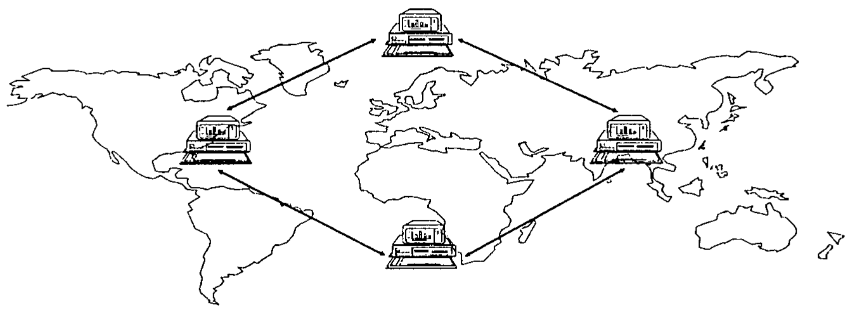
The report reviews 3D display technology applications in several major areas: flight deck displays, air traffic control, meteorology, teleoperation and robotics, computer-aided design, and graphic data analysis and imaging.

Senior author of the report, Dr. Christopher Wickens, is head of the Aviation Research Laboratory, University of Illinois.

The report is 126 pages and includes 22 figures. Cost is $75. To order, contact the CSERIAC Program Office.

The Air Force Lessons Learned Program

Pat Nickell



Experience is the best teacher and that's what the Lessons Learned Program is all about. A lesson is simply a recorded experience of value in conducting future programs or modifications.

The Air Force Lessons Learned Program is a corporate memory bank of past program experience, both positive and negative, that is available to DOD employees and certified government contractors through on-line access. Army and Navy lessons are also screened quarterly and appropriate lessons entered into the data bank. The program is managed by the Acquisition Logistics Division's Lessons Learned Program Office at Wright-Patterson Air Force Base. The purpose of the program is to transfer knowledge gained through experience from those who have it to those who don't.

The Lessons Learned staff can assist customers by providing packages of lessons for a particular impact area, such as Configuration Management, Contract Management, Program Management Responsibility Transfer (PMRT), etc. Our data bank contains lessons grouped into 60 different functional or impact areas. Impact areas can be added or deleted as necessary. The data bank can be searched by impact areas, keyword, or program phase. Lessons Learned can and should be used in every phase of an acquisition program.

The Lessons Learned staff is continually receiving feedback from users and reviewing the data bank to update or delete when appropriate. User feedback helps us make improvements and ensures that the lessons in the data bank are significant, valid, and applicable. The data bank undergoes an annual revalidation to ensure that the lessons are current and up to date. We can get more from our limited resources by analyzing both positive and negative experiences. The use of lessons learned is the key to improved reliability, maintainability, lower costs, supportability, readiness of present and future weapons systems, and to improving the way we do business.

The Lessons Learned staff is currently developing a P.C. version of the data bank which will be operational in early 1991. This version will make it easier to access the data base and will be more user friendly than the current version.

We welcome lesson submitters and lesson validators. Guides on how to write and validate lessons and forms for submitting lessons are available upon request . You can enhance the Lessons Learned Program through your participation. You may discover a new process or innovative technique or see where improvements can be made. The objective of the program is to improve the acquisition process by not repeating the same mistakes over and over. While the bulk of lessons maintained in the data bank are acquisition related, we are expanding to include lessons in operational areas such as Blue Two, *TechTIPS*, *TechTAPS*, *IG Briefs* and others. Blue Two is a program named after the Air Force's blue-suited two-stripers, that allows contractors to work side-by-side with airmen on base flightlines, worldwide. Contractors gain better understanding of how the systems they design perform in operational conditions. *TechTIPs* are short descriptions of proven technologies, processes, or products which offer alternative solutions to help resolve supportability problems. They include information applications, benefits and drawbacks, as well as the technology and user points of contact. *TechTAPs* are short descriptions of agencies or programs that offer technical knowledge and assistance and help support efforts to resolve supportability problems. ALD/JT, Wright-Patterson AFB OH 45433, DSN 785-7900/785-1606 or Commercial (513) 255-7900/255-1606 can offer further information on these programs. No area is too small for us to learn from it. Both the DOD and industry can benefit from your experiences. We need to hear from you!

The Lessons Learned staff (Capt. Julio Rivera, Bob Kerr, Ms. Pat Nickell, MSgt. Jack Gillum, SSgt. Mike Slisz, and Ms. Nancy Bach) stands ready to assist you in submitting lessons, retrieving lessons from the data bank, providing on-line access, or providing the Lessons Learned briefing and training on how to write and validate lessons.

You can take advantage of the services of the Air Force Lessons Learned Program Office by contacting ALD/LSE, (513) 255-9689. You may also leave a message after duty hours by calling DSN 785-5238 or COMMERCIAL (513) 255-5238. ●

Pat Nickell is a member of the Air Force Lessons Learned Staff, which is part of the Acquisition Logistics Division, Air Force Logistics Command.

Modeling Human Force Response

Norm Phillips

Human force response to an acceleration has been observed and measured for many years to provide design criteria for the development of safer designs of aircraft, automobiles, tractors, and lifeboats, to name a few examples. From vibrational tests with live humans, it was possible to determine a model, an analytical model with elastic, viscous and inertial properties, which could replicate the measured force response for the given sinusoidal input. This was then related to ride- comfort and vibrational tolerance.

Similarly, tests were conducted with subjects exposed to impact accelerations and again the force response of the subjects was measured for kinetic and kinematic analysis. The nature of the response was modeled and again related to tolerance. In both instances it was possible to represent the human by a simple single-degree-of-freedom model.

Since the simplified models were first developed there has been significant change in the data collection process, in the processing and presentation of the data, and in our capability to improve the sophistication of the predictive models. Models such as the Articulated Total Body (ATB) Model, the COMputerized Biomechanical MAN-Model (COMBIMAN), and the Head-Spine Model, available through CSERIAC, are indicative of the current capability to predict gross motion, physical accommodation, and spinal stress. There are, however, additional prediction requirements created by environments such as those of the next generation of escape systems.

Future designs of escape systems for single crewmembers may be lightweight seats with controlled thrusters, movable fins, and an onboard computer. The seat becomes a miniature aircraft with some of the problems associated with the parent aircraft. This is particularly true when the mass of the subject becomes a significant portion of the weight of the system, and the inertial response of the aircrewman to the ejection acceleration generates large forces and moments. The control system of the seat must be capable of responding to the commands that dictate the trajectory required while reacting to the response of the aircrewmember.

The original force response models of the human were created from impact data available at the Harry G. Armstrong Laboratory (AL; formerly the Harry G. Armstrong Aerospace Medical Research Laboratory, AAMRL) in the mid-1960's, and were generated by finding a model which would replicate a measured acceleration on the seat pan directly beneath the subject. Knowing the input forces applied to the structural test configuration, and calculating the effects of the rigid body structure, the difference had to be created by the human. The model found had an undamped natural frequency of 10 Hz in the spinal direction and is referred to as the "10 Hz" model. This differed from other representations of the day, the vibrational representation (5 to 6 Hz) and the injury representation (8 Hz), and was suspect because of that. One reason for the suspect nature was that the force response of the human was inferred from acceleration data whereas the vibrational and impedance techniques of the day were based upon direct force measurements beneath the seat pan.

Over the years as the measurement capabilities improved, more test programs have been conducted with increased numbers of data channels and with greatly increased data storage capacity. This has provided the test planner with the capability to require full force measurement of the human response during acceleration or deceleration experiments. Any component of the test environment that creates an interface with the human can now be instrumented. For a seated subject it is possible to instrument the restraint straps, the seat belts, and negative "g" strap if applicable, the head rest, the upper seat back, the lower seat back, arm supports, the seat pan, the leg rests, and the foot rests. This information is supplemented by kinematic data such as the accelerations of all structural components, and by high-speed photography. Hence, some data contain both the kinetic and kinematic response of the human to acceleration environments, and the force response can be extracted from force data and not just inferred from other measurements.

A wealth of this type of information can be found by making use of facilities of the Biodynamics Data Bank at AL. As discussed in a recent issue of *Gateway*, the data bank contains the information necessary to identify those tests which satisfy specific requirements such as full body force measurement as mentioned above. A search of the data base indicated that full force measurements were made for vertical impacts of live human subjects at AL under the test plan title of "Vertical Impact of Humans and Anthropometric Manikins." The summarized data from the data base provided the names of the investigators, the test protocol identification, the test matrices with control parameters and their values, instrumentation used, channel allocation and calibration, test objectives, and any comments necessary to supplement the data. From this information it was known that ten subjects of a test panel had been exposed to a vertical deceleration of two different levels with three different seat positions and two harness configurations. Fifty tests were selected as candidates for later examination to determine whole-body force response.

The data found are indicative of that which is sometimes available for analysis. The data were collected for the purpose of comparing the response of human and anthropomorphic manikin, and not for evaluation of human response alone. This is not unusual for an "operational" test requirement where measures of improvement are desired rather than in-depth investigation of the measured data. Many tests are sometimes necessary to "measure" the improved response as created by a new harness or a new seat cushion. The changes in the force distribution and phase are usually not included as objectives of the testing.

The forty channels of data collected for the Vertical Impact of Humans and Anthropomorphic Manikins, +Gz Tests, (VIHAM), were examined in depth for one particular test. The test selected was one with an 8G peak deceleration, of 150 milliseconds duration, with a triangular waveform. The subject was 163 pounds, supported by an X-band harness, with legs dangling beneath the structural seat as shown in Figure 1. This was therefore similar to the test conditions used for the original vertical impact tests 25 years ago.

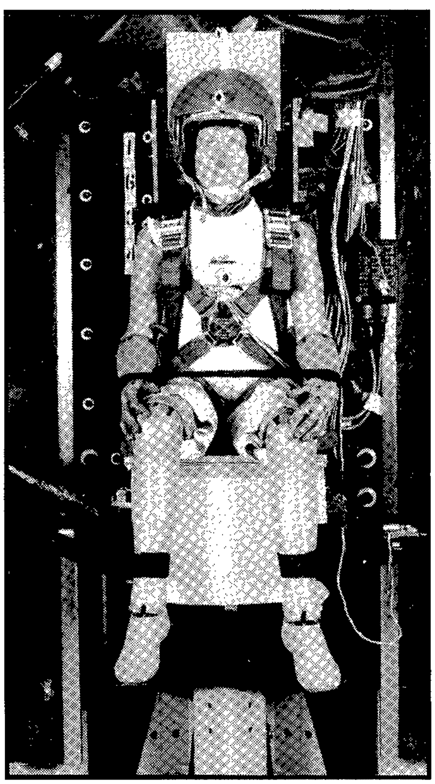


Figure 1. Example of structural seat used with human subject

The test data contained carriage accelerations, seat accelerations, chest and head accelerations, and 25 channels of force measurements to be examined. The examination revealed that, because of the calibration techniques used and the subsequent creation of the digital files, it was necessary to integrate data of five different coordinate systems into one most applicable to escape system design. Once the nature of the data was established, a digital program was written to accept floppy disks from AL for the test selected.

The mass and center of gravity data were available for all components of the test equipment as were all locations of the accelerometers and force cells. This, in addition to the strap angles available from high-speed photography, permitted calculation of the force and moment resultants acting upon the seat as desired for the escape seat design criteria. Based upon the information provided, the seat forces had less than a maximum imbalance of 15 pounds during free-fall, and less than a 10-pound difference from full body weight after impact. The measured post-impact weight acted at a point 8 inches forward of the seat reference point, a reasonable value for the subject tested. (Complete anthropometric data for each subject were available from the data base.) The program that evolved generated the three-dimensional force and moment contribution of every measured force, as well as the resultants, as functions of time for the duration of the acceleration pulse.

A simple linear elements-nonlinear configuration model of the seated human was evolved and programmed to replicate the measured force response of the seated live human. The model consists of one mass suspended in space by a vertical element, and two elements going diagonally from the mass to locations outboard and behind the mass. This configuration is designed to provide a model that visually represents the seated human supported by "shoulder harness straps" going from the mass rearward and upward to shoulder harness attachment points.

The single mass representation was programmed to accept three-dimensional translational accelerations acting at the "seat" surfaces of the seat pan and seat back. All elements were modeled as linear viscoelastic elements having the capability to elongate but not carry compressive loads. The locations of the attachment points can be selected arbitrarily, as can the viscoelastic properties and the supported mass.

Many combinations of parameter values were attempted to match the measured resultant force and moment responses in the plane of symmetry, as would be required for an assumed coplanar escape sequence. By using the known weight of the subject as that of the suspended mass, and by locating the mass at the center of gravity of the seated subject, based upon the location of the fiftieth-percentile subject, and by locating the strap attachment points at 10 inches either side of the centerline and at shoulder height, the computed resultants were compared with those measured as shown in Figures 2 and 3.

The comparisons shown have peak values that are within ten percent of those measured for the greatest difference, and are within one percent of the maximum if an rms value is calculated for the differences between computed and measured for every millisecond. The model results shown are for a model having an undamped natural frequency of 9.14 Hz and a damping ratio of 0.48. This compares favorably with the original 10-Hz model which was evolved without the benefit of measured forces, and implies that the original model's predictive capability can be extended, if it is now located properly with attachments, to replicate both the force and the moment response as functions of time.

An interesting aspect of the model is that the nonlinear response changes the "natural" frequency because of the elongation of the viscoelastic elements during the response. At the maximum

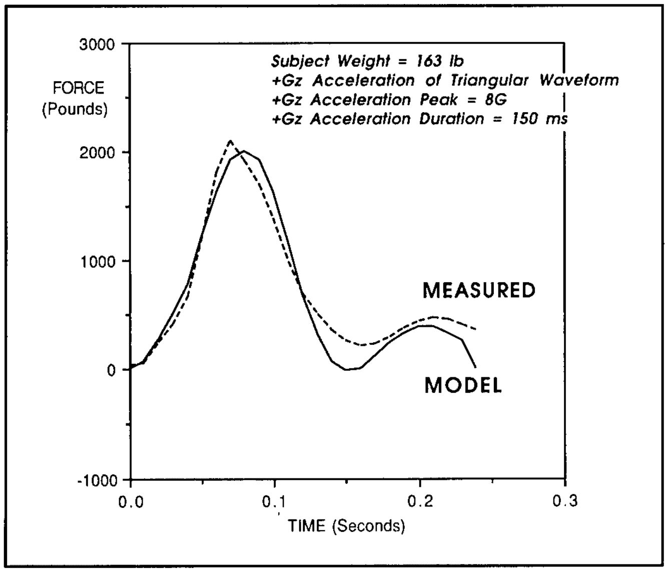


Figure 2. Computed Model Vertical Force Response Compared with Measured Resultant Vertical Force

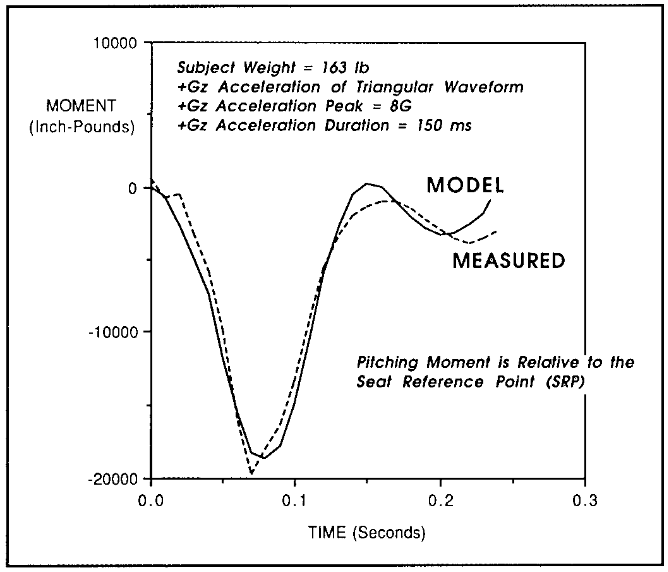


Figure 3. Computed Model Pitching Moment Response Compared with Measured Resultant Pitching Moment

deformation due to the input acceleration of the selected test, the model's instantaneous natural frequency, based upon the vertical stiffness at that point, is less than that at the equilibrium location. The natural frequency at maximum extension is 8.59 Hz with a damping ratio of 0.8. This is interesting in that the change in frequency is toward the accepted natural frequency of the DRI model currently used for spinal injury prediction. This implies that one model may have the capability to predict both force and injury response of the seated live human subject to a vertical, translational, impact deceleration.

The results presented above were generated using programs developed to extract information from data currently available, and to model it with a new representation. The results are for just one test but it is suspected, based upon results in the literature, that the characteristics of the model are applicable to the entire population. Similar studies of data available for the Gy acceleration input and the +Gx impact acceleration, both for a seated live human subject, have also been conducted, and models were found for restrained human response in the lateral and fore-and-aft direction.

Unfortunately, each study was limited to one test in each direction and additional analyses should be conducted before the newer characteristics are published. The vertical response model characteristics can be compared with previous results. Lateral and fore-and-aft whole body force response models do not exist. Therefore, any verification of those model characteristics must evolve with the study of many other tests conducted with a range of subject sizes, restraint systems, and input acceleration waveforms. The data await the next investigator.●

Norm Phillips is an Associate Professor of Civil Engineering at the University of Dayton.

Chief Scientist's Report

Don Polzella

The Visual Performance Technical Group of the Human Factors Society is interested in research and applications of all aspects of vision as it affects performance in user-machine systems, and it is a challenge for its members to maintain their awareness of the vast and growing amount of technical literature in this area. Technical Group Chair David Post and Newsletter Editor Maxwell Wells wondered if CSERIAC might help by providing a "current awareness bibliography." In response to their request, we first developed retrieval strategies, consisting of key words and phrases, for PsychINFO, NASA, COMPENDEX, and DTIC bibliographic databases. (This was not as straightforward as it might appear. For example, whereas "vision" would probably be an appropriate retrieval cue for engineering journals, it would hardly do for the visually oriented *Journal of the Optical Society of America!*) We next searched the databases for technical reports and journal articles of interest. Finally, we extracted a representative sample of abstracts for publication in the Group's quarterly newsletter. We are continuing to provide this service each quarter.

A Government engineer needed information on procedures for obtaining foreign specifications and standards, particularly those of the DIN (German) and Defense Research Establishment (Canadian). We found the information in the Defense Technical Information Center's *How to Get It* (DTIC/TR-89/1, AD-A201 600), which is a reference tool to identify and help acquire documents, maps, patents, specifications and standards, and other resources of interest to the defense community. Foreign industry standards can be obtained from the American National Standards Institute (212/354-3300), and the National Standards Association (301/951-1310), among others. Specifications and standards, which are applicable to NATO members (STANTAG), are obtained from the Naval Publications and Forms Center (215/697-3321).

The Airline Pilots Association requested information on tape displays - a "fixed pointer, moving scale" display in which flight data are displayed by a horizontal or vertical pointer that remains fixed while a vertical or horizontal scalar tape is moved to indicate a change in some flight parameter, e.g., altitude, airspeed. We searched the NASA, DTIC, COMPENDEX, and NTIS databases for bibliographic information and NASA-STD-3000, MIL-STD-1472D, and AFSC DH 1-3 for design guidelines. We found that the use of tape displays is sometimes necessary, but certain ambiguities arise when the design guidelines are followed, e.g., downward movement of the tape is linked to upward movement of the vehicle. The performance consequences of such incompatibilities are uncertain, but the use of the more conventional fixed scale, moving pointer displays are recommended to avoid any possible confusion.

An automobile company requested information on human engineering/human factors considerations in the design of a driver-display interface. Specifically, they were interested in information concerning human performance and vehicular control problems that may occur when data displays are integrated within a passenger vehicle (e.g. automobile, truck, taxi, police car, bus, etc). We provided them with a "CSERIAC Search and Summary" based on information extracted from DTIC, TRIS, PsycINFO, and COMPENDEX databases. In addition, we enclosed a copy of Thomas Goesch's article "Head-up displays hit the road," which appeared in the September 1990 edition of *Information Display*. The article contained an overview of the issues involved in integrating virtual-image displays in automobiles. We also enclosed several entries from Boff and Lincoln's *Engineering Data Compendium*, which contained relevant information and data on attention switching, display size effects, monitoring performance, person-computer dialog, and target coding.●

CALENDAR

April 28-May 2, 1991
Columbus Ohio
Sixth international Symposium on Aviation Psychology, Columbus, Ohio, sponsored by the Ohio State Aviation Department and the International Journal Of Aviation Psychology, at the Hyatt Regency. Contact Richard S. Jensen, Dept. of Aviation, Ohio State University, P.O. Box 3022, Columbus, OH. 43210-0022; (614) 291-5460, fax(614) 292-5020.

May 1-3, 1991
Dayton Ohio
Interface '91, Seventh Symposium on Human Factors and Industrial Design in Consumer Products, sponsored by the HFS Consumer Products Technical Group in cooperation with local chapters of IDSA and HFS, at the Stouffer Plaza Hotel. Contact Jay Pollack, JPC Rm 300, University of Dayton, 300 College Park, Dayton, OH. 45469-0110; (513) 229-4235.

July 15-20, 1991
Paris, France
11th Congress of the International Ergonomics Association. Contact J. Monnier, Secretariat IEA 91, Laboratoire d'Ergonomie et Neurophysiologie du travial, 41 rue Gay-Lussac, F75005 Paris, France; fax (33) 1.47.07.59.01.

September 2-6,1991
San Francisco, CA
35th Annual Meeting of the Human Factors Society, sponsored by the HFS Bay Area Chapter, at the San Francisco Marriot. Contact HFS Central Office, P.O. Box 1369 Santa Monica, CA 90406; (213) 394-1811 or (213) 394-9793; fax (213)394-2410. *Abstract deadline: February 4, 1991.*

May 1-3, 1991
San Antonio, TX
Seventh International Occupational Analyst Workshop, sponsored by the USAF Occupational Measurement Squadron, at the Radisson Hotel. Contact Capt. Ron Schrupp, Randolph AFB, TX 78150-5000; DSN 487-6811 or (512) 652-6811

Wanted: A Scientific Basis for Human Vehicular Control

Rik Warren

Every day, we learn about vehicular deaths. Usually the vehicle is a car, but we read about boat, train, plane, and even bicycle accidents. Although the cause is sometimes external to the operator, far too often the human is a factor. We in the human factors community want to reduce accidents and permit operators to achieve their primary goals with well-designed user interfaces.For us to do so, these interfaces should incorporate the best available research about what information users need and how they use it.

Whatever the goals of a particular vehicle operator, all must successfully exercise basic vehicular control. They need to know where they are, where they are going, how far away to a waypoint, how fast they are traveling, how responsive their vehicle is, and what their relationship is to the general environment and other moving vehicles.

It is easy to take these tasks for granted and assume humans have unlimited abilities. But such an attitude leads to less than optimal designs, since modern technology has increased the demands on humans far from those of strolling in the woods or racing a horse. Vehicles are snappier (fighters), more massive (supertankers), more visually demanding (night vision aids), and more workload demanding (evening commutes) than ever before. Hence, the interface should be sensitive to what is known about perception and control of self-motion in general and capitalize on what is known about the specific demands or tolerances of the particular mode of travel.

We routinely teach driving in high schools, and thousands of planes take off and land each day. Yet, despite much applied research, surprisingly little is known, in a fundamental sense, about perception and control of self-motion. We simply do not have a theory of self-motion or a body of indisputable empirical facts upon which to base optimal interface designs. Lack of a good theory means that the design drivers for real vehicle interfaces and training simulators are budgets and technological availability rather than well-understood human needs. This can be wasteful and unsatisfying.

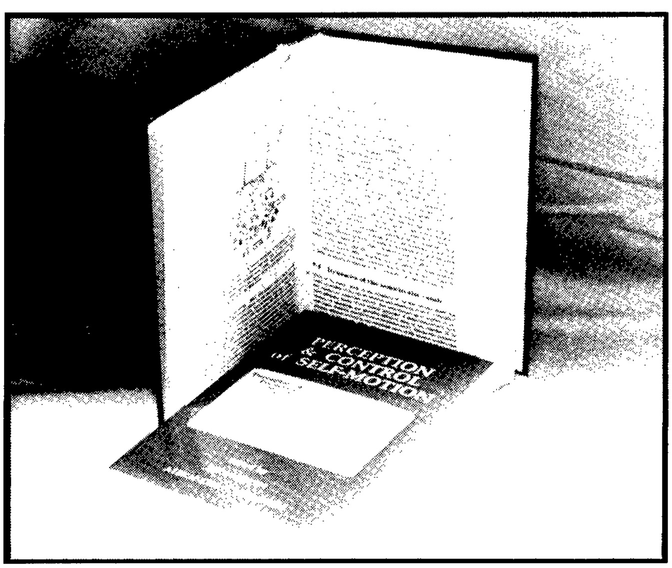
Fortunately, there is much interest in the problems of self-motion, and a growing number of respected basic researchers from many disciplines are actively seeking understanding. In addition to more research, what is needed now is better communication between basic researchers and designers. That communication should work in both directions, for often scientists get their best ideas tackling a real-world problem.

A new book, *Perception and Control of Self-Motion*, which is currently available through CSERIAC, addresses this growing area of basic and applied research. Its 22 chapters include introductory and overview treatments as well as detailed technical sections which represent the state of the art. The book is useful to graduate students and to researchers in experimental psychology, transportation, and human factors.

The 29 contributing authors represent experimental psychology, aerospace engineering, comparative physiology, medicine, physics, and control engineering. The self-motion area covered ranges from the underwater environment to space and is populated by bats and blind humans as well as sighted pedestrians and airplane pilots. The emphasis is on basic theory, and several theoretical viewpoints are represented, including the ecological and control-oriented perspectives. Treatments range from the psychophysical, the physiological, the computational, and the engineering model. Visual and vestibular work predominates, but problems of sensory intergration and non-human systems are also treated.

The book has 672 pages, over 130 figures, and extensive author and subject indices which contribute to its value as a reference source. CSERIAC is distributing this volume through special arrangements with the publisher, Lawrence Erlbaum Associates.

The book was edited by Dr. Rik Warren, with Dr. Alex Wertheim of the Dutch TNO Institute for Perception. ●



Dr. Warren is an Engineering Research Psychologist in the Human Engineering Division of the Harry G. Armstrong Laboratory, Wright Patterson Air Force Base, OH.

CSERIAC Conference Services

Jeffrey A. Landis

As part of its mandate to offer human factors support to the design and engineering community, CSERIAC has the capability to provide technical, administrative, consulting, and logistics support for a wide variety of technical meetings, workshops, conferences, and symposia. CSERIAC can manage all functions, including negotiating contracts with speakers, processing registrations for the attendees, arranging for travel and lodging for invited personnel, providing meeting facilities, preparing course notebooks and proceedings, planning and providing for culinary functions, and collecting evaluative data from the attendees.

CSERIAC has the flexibility to manage meetings in a variety of locations, including locations as diverse as Dayton, Ohio, a center of high technology, or Sun Valley, Idaho, a resort community.

Also, CSERIAC offers comprehensive meeting management, from beginning to end. This allows the user the simplicity of dealing with one organization and results in cost-savings.

In addition to meetings CSERIAC has hosted for other organizations, CSERIAC has hosted its own successful short course biannually. The objectives for this course included providing system designers with a human performance framework for addressing equipment-related design problems and sensitizing them to the use of human performance data in the integration, modification, and evaluation of human-machine systems. To accomplish this, CSERIAC selected internationally recognized human factors experts to present lectures whose content and orientation addressed a hypothetical, but realistic, engineering problem. Using a tutorial format, the material presented covered input and acquisition of information, human information processing, and human performance. Opportunities for discussion and asking questions were available at the end of each presentation. At the conclusion of the workshop, the students, who earlier had formed small groups, were asked to present their solutions to the hypothetical design problem.

This was followed by discussion with the subject-matter experts. Ratings from past participants indicate that this course was successful in meeting their needs.

If you are interested in sponsoring a technical meeting, workshop, conference, or symposium, and would like technical or administrative assistance from CSERIAC, or have questions concerning CSERIAC's conference services, please contact the conference administrator at (513) 255-4842 or AV 785-4842. ●

Jeff Landis is Editor of Gateway and Conference Administrator for CSERIAC.

Corrections

We at CSERIAC appreciate reader feedback. Some of our readers have brought to our attention the need to correct two statements. This feedback is necessary and always welcome.

1. It was mentioned in the fall issue (vol.1,no.4 "The COTR Speaks" page 5) that CSERIAC will be the "official host" for all DoD Human Factors Engineering Technical Group meetings. However, this statement is somewhat misleading. CSERIAC was actually contracted to provide its conference services for the two meetings in the previous fiscal year, 1990.The "offical host" is rotated between the armed forces and NASA.

2. In this same issue ("USAF Instrument Flight Standardization," page 11) Air Force Regulation 5-11 should read Air Force Regulation 50-11.

CSERIAC

ARMY NAVY AIR FORCE NASA FAA NATO

NEWS FROM the Defense Logistics Agency's

CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER

- FEATURES OF NATURALISTIC DECISION MAKING
- MODELING HUMAN FORCE RESPONSE
- AIR FORCE LESSONS LEARNED PROGRAM
- A SCIENTIFIC BASIS FOR HUMAN VEHICULAR CONTROL
- CSERIAC CONFERENCE SERVICES

Det 1, AL/HE/CSERIAC • WRIGHT-PATTERSON AIR FORCE BASE • OHIO 45433-6573

Official Business • Penalty for Private Use $300

Bulk Rate
Postage & Fees Paid
Defense Logistics Agency
Permit No. G-53

CSERIAC PRODUCTS AND SERVICES

CSERIAC's objective is to acquire, analyze, and disseminate timely information on crew system ergonomics (CSE). The domain of CSE includes scientific and technical knowledge and data concerning human characteristics, abilities, limitations, physiological needs, performance, body dimensions, biomechanical dynamics, strength, and tolerances. It also encompasses engineering and design data concerning equipment intended to be used, operated, or controlled by crew members.

CSERIAC's principal products and services include:

- technical advice and assistance;
- customized responses to bibliographic inquiries;
- written reviews and analyses in the form of state-of-the-art reports and technology assessments;
- reference resources such as handbooks and data books.

Within its established scope, CSERIAC also:

- organizes and conducts workshops, conferences, symposia, and short courses;
- manages the transfer of technological products between developers and users;
- performs special studies or tasks for government agencies.

Services are provided on a cost-recovery basis. An initial inquiry to determine available data can be accommodated at no charge. Special tasks require approval by the Program Manager.

To obtain further information or request services, contact:

CSERIAC Program Office
Det 1, AL/HE/CSERIAC
Wright-Patterson AFB, OH 45433-6573

Telephone .... (513) 255-4842
Autovon 785-4842
Facsimile .... (513) 255-4823

Associate Director: Dr. Lawrence D. Howell; *Contracting Officer's Technical Representative:* Lt. Col. Philip A. Irish, III; *Director of Special Projects:* Dr. Reuben L. Hann; *DoD Technical Director:* Dr. Kenneth R. Boff

CSERIAC Gateway is published quarterly and distributed free of charge by the Crew System Ergonomics Information Analysis Center (CSERIAC). *Editor,* Jeffrey A. Landis; *Assistant Editor,* Christopher J. Sharbaugh; *Copy Editor,* Anita Cochran